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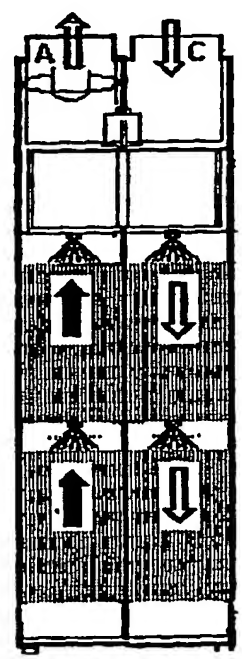
(54) Title: THE SEPARATION OF MICROORGANISMS FROM VENTILATION HEAT-EXCHANGERS WITH EVAPORATIVE COOLING

(57) Abstract

The invention relates to an arrangement and method, (means) to evaporate water in an air to air heat-exchanger and collect and circulate surplus water from the evaporation in the air to air heat-exchanger along with precipitation of condensed water (dehumidifying of air). Separation of surplus liquid and contamination's from ventilated air is accomplished through preferably allow supply air and exhaust air in the heat-exchanger first have the streams pointed downwards towards a collecting sump and thereafter pointed upwards whereby kinetic energy and/or gravity in the surplus water and material is collected in the collecting sumps at the bottom of the heat-exchanger. After that draining, drying, heat sanitation take place after which pure water is added and the cooling air conditioner is restarted. When dust and microorganisms have been collected in sufficient amount in the collecting sump the water is changed to clean water. Sterilisation of the arrangement takes place through the use of pre-and/or additional supply of energy that is forced to pass and heat the inner channel system and parts of the arrangement whereby survival and growth environment for microorganisms as bacterium, virus, fungi's become unsuitable within the arrangement and that the air gets rid of aerosols. The method to rinse out the canal system of the heat-exchanger. In the upper part, at need, a sprinkler system is installed to pour water upon and to rinse out the canal system of the heat-exchanger.



The seperation of Micro-Organisms from Ventilation heat-exchangers with evaporative cooling.

Application for the patent with method of proceeding and the intent to proceed with production: From a refrigerated air Condition with atmospheric open evaporation of water in the return (exhaust) ducting it often will transmit infection by, micro-organisms such as bacteria, fungus, viruses, protozoa that join the ventilated airstream in an air conditioner.

We have now sound knowledge that the bacteria "Legionella Pneumophilia" started and spread by the use of vapour and aerosols. The infected person will at inhalation be stricken with an epidemic pneumonia apprehended as it often lead to death. The bacteria also causes fear of air-conditioning and that many types of energy efficient and comfortable ventilation products will be withdrawn from the market.

In this invention the aim is to compensate the fridge-compressor in air conditioners with a new energy effective process. The climatic character of the fridge-compressor is to circulate a cold medium where liquid turns to gas, and the gas back to liquid, causing a transfer of energy. It is a very costly process in energy to compress gas to liquid. This liquid has to be substituted by adding water that is evaporated in an open atmospheric system in an air to air heat-exchanger.

This technique can be understood as follows: One can saturate the exhaust air in the flow ducting. The air can contain ca 4 weight percent water in the form of moisture at 760 mm hg at 20 grad Celsius. Water that in a cycle changes to moisture has a larger volume and a latent heat content that presses the surrounding air molecules. This process sinks the air mass temperature. Our effective refrigeration system uses only energy saving techniques based on natural laws of science.

The present techniques using a fridge compressor is ca 3 X 1.6 X 400 = 1.392 kWh/hour to cool 400 m3 air 10 degrees in 1 hour. Despite this a further 300 watt / hour is needed to move and change the air.

If there is a need to cool the air by 25 degrees : 400 m3 / hour which is the norm in a normal residence. In twenty four hours (2,5 x 1,392 x 24 h) + (0,3 x 24 h) = 90,72 kWh energy is used.

The corresponding cooling of air using effective evaporative heat-exchangers.

Constructed with the technic of the invention the energy usage when cooling can be stated in the following:

Moving of ventilation air 350 watt/hour	=	8,4 kWh /day
Energy to work air flow diverts 10 watt / hour	=	0,24 kWh /day
Energy for water pump 66 watt / hour	=	1,58 kWh / day
Energy to cool 400 m3 air 25 degree	=	10,22 kWh / day

The energy needs to climatize the inside of a residence will consequently drop by 90 percent. With the use of electricity, mostly converted by burning fossil energy, every kilowatt electric energy used to produce cooling consume 2,25 kW fossil energy. The technics of the compressors consume for cooling purpose 230 kWh of fossil burning. The new technic only consumes ca 23 kWh fossil burning.

The invention, heat-exchange combined with open evaporation is correct for use of in the environment, it is cheaper to run, it is cheaper to produce and maintain in comparison with compressors for cooling, but it needs to be adjusted to the local climate. The climate of the whole day and the time of the year affect as well as the nurisment in the air to micro-biological growth and filth.

Very important is to master the function of the equipment to avoid transmission of infection by aerosols, dust and other particles that normally use to be spread from air conditioner. The invention can be used by both regenerative-recuperative/regenerative and recuperative heat exchangers.

By evaporation in the equipment the airstream will receive running water and in the form of water droplets or as steam. As evaporation preferably occur downwards inside the heat-exchanger, the running water and the water-drips an downwards force. The water cooperate with the airstream and the law of gravitation and transport, dust, particles and Micro-Organisms in the heat-exchanger in order to transport them to a collector in the lower part of the heat-exchanger. When the airstream turns uppvard, running water, heavy water droplets, dust and other particles continue downwards and are separated from the airstream. The friction by the air will not transport the water and heavier particles upwards.

Only very small particles, water droplets , steam and air already evaporated water will be transported further on by the airstream. When the cycling is regenerative in the heat-exchanger and used air and fresh air are periodically transported a specially effective cleaning becomes possible. Collection of surplus water and dirt in the container becomes more effective by the periodically changed direction of the air. This hinder the growth by particles. The goal is to collect the dirt in the container in order to keep the equipment as clean as possible.

Regenerative technic, makes more effective cleaning possible and a higher quality of the air than in equipment's that consists of diverted singes direction channel system where dirt grows during long time and causes microbiological growth and the distribution of infection. Continuos transportation away of dirt is desirable to bring about.

A considerable problem that exists in connection with effective evaporative cooling directly in the canal system is that small water droplets which don't evaporate will join the airstream.

As the arrangement sucks air from outside and the up stream part of the duct is placed side by side to the downstream part of the duct for supply it is possible to provide with fresh and warm out door air trough an adjustable bypass that rise the temperature in the incoming air in order to achieve a complete evaporation of water and steam in the incoming air. Micro-Organisms thereby will dry out and be eliminated at the same time as the spread of aerosols is prevented.

CLEANING

The first and the most important moment in cleaning and eliminating of Micro-Organisms in the device for ventilation is to with regularity empty the sump at the bottom of the device The sump dries out and can be heated and refilled with fresh water. This may be automatic through connection of the device to fresh water supply and recipient by means of piping.

With the cleaning by means of heat, we utilise the relationship between the flow and return air that run side by side within the device. With the closing of the flow and return, at the same time as flow and return are connected it is made possible for warm outdoor air to circulate and warm up the ducting. Its important that the hot air passes through both the piping of flow and return and warm i t up in order to sanitate by drying out and pasteurising and / or sterilisation. The energy needed for this is supplied by when fresh outdoor air passes a sun collector or an electric airheater.

The cleaning process takes the warmed up air together with the dried- out contamination, micro biological nurisment that then is set free by forced air. After sanitation the contamination is blown out of the canal system and deposited outdoor. Thereby the warmed up device is cooled and fresh water is filled in the collecting container that also function as storage of evaporating water.

The method of cleaning and the technical solution can be used on regenerative, regenerative/recuperative and recuperative heat-exchangers as evaporation of liquid is carried out in the system of heat exchanger where heat is supplied down stream the evaporation zone or kondensation zone.

Separation of water and large waterdrips from the canal system of the heat exchanger.

By evaporation the airstream is supplied with large droplets and atomised water and steam. Trough preferably allow evaporation down wards, vertical, the waterdrops will have kinetic energy downward. Then the air is led upward whereby large water drips according to the law of gravity are separated and supplied to a sump in the lower part of canal system. Only tiny water droplets, steam and evaporated water are led away.

Small water droplets and steam have towards the surroundings large surface in comparison to its volume. The temperature of the air in the evaporasion zone is less than the outdoor and indoor temperatures. Through heat exchange the temperature of the air will increase and also the ability of the air to dissolve water on its way out of the equipment. Said warming up can be provided from fresh outdoor air or indoor air. The air that leaves the ventilation equipment will receive a higher temperature than the temperature of the air that is in the evaporation zone or condensation zone of the equipment.

The new technic enables the invention to free the airstream from the very tiny small waterdrips (aerosols) that cover bacteria and spread infection. The process can be adjusted as to free the air aerosols and also obtain a relative humidity that creates a to bacteria and other infections negative survival conditions.

Its important to check that the air that leaves the ventilation equipment don't spread infections by aerosols, dust and other particles.

An evaporative ventilation system with open evaporation can be compared with a person that have been infected with a bad influenza and all the time cough and sneeze and distribute extremely tiny infected liquid drops to those around him. It is necessary to regularly eliminate micro organisms that exists in air Conditioning equipment and care for the removal of humulus products from the aggregates.

Water often consists of large amounts of infectious matter. At chemical control the water must regularly be controlled and treated. By heating the system of ducts and cause desiccation (dehydration) of the ventilation system micro-organisms from the infected source can effectual be eliminated and the spread of infections minimises for some time. Regularly sanitation of ventilation constructions is therefor necessary.

It is important that gasification i.e. complete dissolution of fluid in airstrips that leaves evaporative ventilation constructions will be effected. The ability of bacteria and micro-organisms to survive in dry surroundings are very small. Transmission of infection will be prevented if aerosols will be gasified before the air leave the climate unit. That happens owing to flow and exhaust air will be afterwarmed of the heat-exchanger.

<u>31. Principle sketch see fig 1,2,3.</u>

Fresh air channel wall ————————————————————

< AFTER HEATED FRESH AIR < CONDENSATION AREA <

Partition wall————————————————————————

>EVAPORATIVE AREA >AFTER HEATED EXHAUST AIR >

Exhaust air channel wall————————————————————

It is by vaporising possible to locate the coolest part in the vaporiser to a particular zone. The exchanger will in this case be divided up in several exchange functions against respective openings as air to air exchanger try to attain the extreme temperatures.

It is possible with the use of evaporating to keep the coldest part of the evaporator to a prescribed sector. The heat exchanger in this connection is divided in several exchange-functions with respective meanings as air to air heat exchanger strive to keep the extreme temperatures.

As condense area and evaporation area that at regenerative technic by cycling is in the same channel, content the coldest part, inlet and outlet area of the heat exchanger will achieve heat exchange in between room air and the cold area and in between outdoor air and the cold area. This also show the importance that the heat exchange process use a long section in order to efficient separate the temperatures and that the bypassing air is exposed to large surfaces in order to emit and absorb present amount of energy. From experience the air should pass a total length of heat exchager by 2 - 2.5 meter in order to be effective and have a towards the air exposed surface of ca 1 - 2 square meter per kubic meter treated air.

Warm air can carry up more water vapour than cold, therefore the vaporising of water in an open system influences to a great extent of the relative moisture and temperature of the room and the outdoor air. The state of things is like that for the non-professional unnatural courses with sensational cooling capacity in the construction arises. These have of course their natural explanation and must be seen as a further energy saving result when the different perimeters work together in a favourable way.

If the vaporising in the plant take place before the exchanger i.e. upstream the exhaust duct of the exchanger, the lowest temperature on the air flow acquires at the same time, however, as the separation of aerosols to the room from the plant will be the highest.

Aerosol separation from the arrangement can be reduced by vaporising in a bounded zone within the heat-exchanger. This means that additional energy will be added which increase the air temperature before it leaves the heat-exchanger. This state of things can occur in both flow and return air, depending on if the exchanger works like heat recoverer or coolingplant. Raised temperature in the outflowzones of the plant reduces the number of aerosols and dissolves By either place a de-humidifier in the air flow downstream the evaporative heat -exchanger or by warming the air afterwards, before it leaves the plant the number of aerosols can be reduced. The aerosols can also be catched through a hygroscope filter if the fresh airs relative moisture is capable of vaporising the water. Heat must be supplied to vaporise the aerosols. This heat can when vaporising takes place downstream the heat-exchanger gasifies the condensateprecipitation that has not before been separated in the plants air flow duct.

When evaporisation in the exhaustduct begins a distance into the air flow of the heat-exchanger the heat-exchanger upstream the evavaporisingzone of the heat-exchanger will work like a afterwarmer that supplies heat in order to completely gasify the flow of airs aerosols i.e. these extremely small drops of liquid that follow the airstream. At the same time the relative moisture of the flow air will be lower. The costs for improved hygiene is that the temperature of the fresh air increase without that the room is provided with this cooling effect.

A camber that assemble drops or a heat exchanger that collect heat from the air in the room result in a lower room temperature at the same time as the aerosols gasifies which reduce the risk of infection from micro organisms in the airborne water droplets. The supply of heat from the room through the cover of the equipment result in that the aerosols dissolve in the heat exchanger and that the effect of cooling

benefit the indoor climate at the same time as the risk for infection deminish. The reality is that aerosols that carry germs infection will not be stopped by variable humidity shift. A direct mixing with warm fresh air together with the damp and cool will dry up the aerosols more effective. Mixing by warm outdoor air that trough a bypass is added to the cool fresh air offer increased possibilities to control the flow and the moisture content.

41. Ventilation free from aerosols.

Legionella Pneumophilia and other diseases that are infectious for people and the buildings are spread from lakes and watercourses, on land and in the air. Just these types of bacteria increase in warm water system and in the environment of a ventilation duct where water stands and the temperature is correct for bacteria to grow. The bacteria spreads by air infection, by water droplets, dust or small particles (aerosols) which are in the air of a ventilation system.

The water in which the bacteria increases can be treated with chemicals that kill bacteria and viruses. UV-bombardment is an alternative but is not a bacteria safe result. Chemical treatment damages the cell-wall and causes the death of the bacteria. The method is not reliable , work intensive and costly and dangerous for human health and the environment.

The most effective method to destroy bacteria and other micro organisms are trough a rise of the temperature. The ventilation equipment have then to regularly be heated . preferably daily under a 10 minutes period. The process can be compared with pasteurising of the micro organisms. It also dries and decomposit the rest.

At plus 45 degree Celsius protein is damaged and get stiff . At temperatures above + 70 degree Celsius the heat sensitive enzyme system of the bacteria is knocked out which causes metabolic disturbance and the bacteria dies. A culture of bacteria that has been developed in a ventilation system can consequently be eliminated.

To enable an infection caused by the ventilation system to pass on to a person a decease developing organism is needed, a sufficient amount of them and that they can reach the right tissue and organ. It is for that reason important to hinder piling up of nutriment needed for the growth of the micro organisms in the aggregate and hinder the spread of micro organisms.

In a ventilation system a large number of airborne nutriment, moisture with right degree of temperature and acidity oxygen of necessity for the metabolism and growth. The nourishment consists priminarly of coal, nitrogen, sulphur, oxygen, and hydrogen. Different bacteria raise different demands regarding to types for that

reason there is no universal method to hinder the growth of bacteria. When the growth have reached a certain point the cell is ready to multiply through cell-division. A Process according to the species can take 15 to 30 minutes up to several days. As continuos supply of nutrition take place by way of the air that passes trough the ventilation system the growth of bacteria and the amount of waste products grow and causes new hygienic problems.

Bacterius and other one-celled organisms lives in and is depending of a humid environment to be able to grow. The tolerance against dehydration is poor and cause the death of the majority of the Bacterius, even if exeptions exists. Many Bacterius grows and propagate faster in the dark than in the light. Most Bacterius prefer light alkaline environment (pH somewhat above 7) or neutral solution.

Virus live inside in a host cell and is three by inaccessible for outer influence. Outside the host cell the virus particle cant propagate. in similarity with Bacterius virus cant stand strong heat bur survive cold temperature well. Some spices of virus cant stand sunlight. Virus that are spread by ventilation systems cause a number of infection disease of which colds and coughs are the most common. Different types of viruses make use of different types of Bacterius as host cells.

The humid and by organically materials nutrious environment that exists in ventilationsystems is suitable breeding ground for fungi's and protozoa. The fungi's form among others downy mycelium and gets its nutriment from organic material without assimilating energy from the sun with assistance of chlorophyll. Protozoa lack cellular tissue but have cellmembrane which gives them a irregular and changing shape. They are primilarly stagnant water which points out the importance that ventilation systems with evaporisation of water regularly is dried out and being heated in order to kill different forms of micro organisms and to make it possibly to remove contamination's.

Most Bacterius that causes illness to human feel comfort in temperatures around +35 to +37 degree Celsius. At low temperatures Bacterius grow more slowly, at minus they cant propagate but they still are alive. This in combination with violent changes in temperature and humidity is the cause to that regenerative heatexchange including a certain mixture in between fresh and used air can occur without causing health hazard . A far too low airchange caused by the demand do deminish the heating costs for ventilation is more health hazardous than that the heatexcanger may release. By increased airchange at heat exchange the health hazard reduces both from the micro-organisms from the air conditioner and the room air.

Energy saving

Today common method to cool the rooms of a building is to install Air conditioners fitted with circulating refrigerant and compressor that continuously change its phase from liquid to gas and from gas to liquid. To cool with these air conditioners large quantities of energy is used. Generally only one third of the provided energy is changed into useful chilliness.

In order to run air Condition with compressors mostly electrify that is produced through fossil burning. In order to turn fossil fuel to 1 kWh electrify 2,5 kWh fossil energy is used. In practice this mean that You need to consume ca 7 kWh fossil fuel in order to cool 1 kWh. This is for the environment very harmful process that many scientists wish to forbid.

By changing to an open evaporating system according to the invention a liquid evaporate, as water, in a air to air heat exchanger. Thereby a very positive cooling process is received that lower the temperature of the ventilated air. It is possible to improve indoor climate at the same time as destructive energy use are diminished. As principle it becomes possible to cool and heat ventilated air with the use of less than 10 percent of the energy used by compressor technics of today.

The technic of energy saving developed by this invention will in the future probably correspond to very profitable part of the worldmarket. A technically advanced energy saving industry is possible to develop that diminish harm caused by one's environment and save limited natural resources.

A change from the cooling compressor technic of today to a global system that make use of air to air heat exchange with open cooling by evaporation is estimated to diminish the global outlet of carbon dioxide by 10 percent in the future. This is equivalent to 10.000 billion kilowatt hours every year as 40 percent of the global energy today is used to the purpose of indoor climate and that the ventilation correspond to more than 30 percent of this energy consumption.

Fresh useful ventilated air will with regenerative air to air heat exchanger be preheated or cooled to 90 percent of the temperature efficiency with energy that is recovered from exhaust air. Furthermore can the useful ventilation air that is brought into the building by evaporative cooling be cooled another 10 degrees Celsius.

The explanation is effective heat exchange technic and evaporisation of water. Much less energy is used to transport existing water to an open in a heat exchanger than to constantly change freon-gas to liquid in a sealed circulating system where the liquid then is changed to gas to collect heat.

FIG 4. show the evaporisation process.

The drawing show when ice is supplied by heat the temperature arise and that it by change of phase from ice to water much energy is used without raise in temperature. When the ice have changed to liquid very little energy is used to raise the temperature until then that the liquid shall change phase to gas at the boilingpoint of the liquid.

The invention is based upon the very energy consuming phase change from water to gas to cool the ventilated air and the indoor climate. When cooling is desired the aim is to take away as much energy as possible by use of a process that need as much energy as possible and lead energy away from the building and installation by exhaust air.

As we know that we always need to ventilate indoors in order to transport away stale polluted air and as air have the ability to dissolve ca 4 weight percent water before the humidity reach 100 percent, there is possible to cool the fresh useful air. The technic are based on known laws of nature but knowledge haw this laws of nature should be used and the technical outfit for this have been missing. We can through the invention now both heatexchange the temperature of the fresh air and cool the heat exchanger by evaporisation of water in the air that leaves the building.

More energy is used to evaporate one litre of water then to melt 7 kilo of ice.

When water is turned to gas its volume increase. The gas has to press surrounding gas molecules away to gain place. For this energy is needed that is bound in the gas without increasing the temperature in the air. The heat gets from the airstream which in turn gets its heat from the heat exchanger. The heat exchanger gets heat out of the warm fresh air which is aimed to be cool before it gets inside the house.

The disadvantage with a circulating cooling refrigerant in the coolingsystem of the air Condition is that this works independent of surrounding climate. great advantages are high energy consumption and that freon gas damage the ozone layer and the environment.

Evaporative cooling in an open process

Cooling efficacy i an air stream can be reached by water supply. Heat is used to increase the temperature of the water whereupon the water can be led away from the air stream. The water also can evaporate whereby heat is used to change the phase in the water to steam and gas. Heat is also used to increase the temperature of the gas.

Trough cooling the out door air in a heat exchanger, further cool trough water injection, with wick or mechanical water supply, remove water surplus with refrigerating plant or absorption and have the water evaporating in the exhaust airstream before and under the heat exchange a favourable process with circulating energy quantities is reached. The invention now enables that surplus of humidity can be removed without refrigerating plant. In many of the climate zones of the earth it is enough with water injection, if the humidity supply in the premises is small.

To enable water to evaporate in the heat exchanger and cool the air water supply in the airstream is needed, supply of heat to increase the temperature of water and air, that the air can not fully absorbed water and the heat needed for evaporisation. The process becomes more effective when the water and the evaporative heat exchanger have large surfaces that facilitate assimilation and emit . The heat exchanger may comprise of several parts connected in parallel or series. It shall always be elongated in order to allow good separation of temperature.

The method of the invention is to provide heat from the heat exchanger when large water particles have been separated and evaporate airborne water drops and steam which have great importance to hinder the spread of living micro organisms and harmful humus impurities dissolved in water. The technic with effective gasification of water is a process of cleaning.As the temperature increases the ability to dissolve water to gas increases.

<u>The weight of the steam in one cubic-metre of air that has been saturated with humidity, gram.</u>

Temperature C	weight of steam, gram
-20	1,00
-15	1,5
-10	2,22
-5	3,26
+/- 0	4,74
+5	6,67
+10	9,4
+15	12,83
+20	17,3
+25	23,05
+30	30,37
+35	35,24

As evaporisation occur in the heat exchanger while the temperature increases, the cooling of the heat exchanger increases. The gas is clean. Gas has a larger volume than the added liquid. Latent energy is in the process turning water to gas.

The gas press surrounding molecules aside and give place for the increased volume of the water after changing phase.

In climate zones with high relative humidity in the outdoor air and large difference in temperatures in between indoor and outdoor temperature possibility to use evaporative cooling if the exhaust air is dehumidified and a low relative humidity is established. As the temperature of air inlet can be reduced lower than the room temperature possibilities is created to dehumidify by condensation in the heat exchanger.

The condense is always building up without possibility to evaporate as the air is filled with humid. When sufficient amount of condense has precipitated it pour and is diverted from the airstream and transported to evaporisation in the exhaust canal. By some rise of the temperature upstream condensing zone in the heat exchanger the condensation will be discontinued and airborne water particles and steam gasify before the fresh air is brought into the room.

The installation dehumidify consequently the fresh air and the humidity can be transported trough the exhaust where it is evaporated and contribute to the cooling of the fresh air. The technic enables that the high humidity of the out door air is stopped from getting inside the house trough controlled ventilation. By evaporisation of the condensed water the provided becomes dry and contribute to a more dry indoor climate and a increase in evaporative cooling when the air later is transported out through the ventilation system.

If the fresh air is not dehumidified in the exchanger it becomes filled with humidity when introduced into the house and will not thereafter have the ability to dissolve an amount of air enough to reach an effective cooling by evaporisation when it is transported out of the room.

If the outdoor air upstream the evaporative heat exchanger are preheated the additional heat will become evaporating heat at the same time as the higher temperature deminish the relative humidity of the air. This increases the ability to the air to change phase from water to steam/gas. With an effective heat exchange it thereby is possible to take away large quantities of bound energy in steam /gas from the exhaust airstream in the heat exchanger at the same time as the fresh air is cooled i the heat-exchanger

To preheat the air that is to be cooled consequently increases the evaporisation process. Fans and fanmotor ought when cooling be placed on the same side of the heat exchanger as the outside air. At heat exchange wintertime they ought to be placed on the room side. The fans by then will give an additional heat of ca 10 %.

Outside air may before entrance into an effective air to air heat exchanger have received an higher temperature that in some ways makes it possible to cool the air through evaporating process and heat exchange to a lower temperature than the air had before it was preheated and even lower than the temperature of the exhaust. This is caused by that the exhaust air have an higher relative humidity than the outdoor air. Additional energy is needed to generate cold.

A specially favourable preheating is obtained when the out door air preferably is preheated by surplus energy from for example a dehumidifier run by compressor downstream the heat exchange or when the out door air passes a sun collector up stream the heat exchanger.

To gains a more even temperature in the preheated air energy may be stored for a short time in the accumulating mass of the sun collector or in an other way. *

In cyclic heat exchangers it is often mentioned about run the risk of micro biological growth. The research has shown that at cyclic heat exchange the air on its way trough the ventilation system is exposed for many variations in temperatures and air humidity that causes a unfavourable survival- and growth surroundings for micro organisms, Bacterius, virus, funguses and similar.

Preheating of the out door air upstream the evaporative heat exchanger that may be of regenerative, recuperative, or regenerative/recuperative combination of air to air heat exchanger makes it possible to sterilise the installation by heating and dehumidifying by pre airheater.

This take place in such way that the preheater that preferably is a sunheater through which out door air passes into the ventilation system warm up the air that there after passes trough the remaining closed ventilation system and that the heated air instead of passing trough the air inlet to the room (8)it is directly connected to the exhaust air canal inlet and there after is led out of the ventilation system outdoors. Then all inside parts of the ventilation system are heated, dehumidified and sterilised from living micro organisms.

A cleaning process that if automatic and regularly make maintenance and cleaning of the installation without expensive daily service. Fig.2.

The preheater for outdoor air upstream the heat exchanger has at heat exchange in cold climate been tested according to the possibility to increase the temperature efficiency of the ventilation system. The upstream or in beginning of the exchanger towards outdoor air open inlet provided heat is divided optimally the evaporative heat exchange process and self-regulating process for energy supply, evaporisation and effective heat exchange in elongated separation of temperatures in-between out- and indoors.

Experience show that temperature rise with preheater as what is called earth pipe,(a ventilation channel buried in the ground) or air heat exchange due to the high efficiency only marginal has been able to increase the temperature of the fresh air. A sunheater test for a while gave more energy at heat recovering when it instead was used as remaining heat after the heat exchanger.

Cooling of ventilated air by means of heat for evaporisation have been carried out with heat exchanger. Water have in that connection been provided with exhaust air in the exhaust canal before the heat exchanger by wet cotton fibres. To provide atomised (sprinkled) water directly into the airstream have shown great advantages. To provide a small but for the evaporisation enough amount of water is of importance that the water not shall cause improved air resistance in the ventilation system.

Evaporisation of water in the exhaust canal occur when the exhaust air is not saturated that the air have ability to dissolve a larger amount of humidity as steam / gas. At temperature raise the air have ability to unite to a n increased amount of liquid. Exhaust air mostly have a higher air humidity and is because of that more energy rich than fresh ventilated air.

The low temperature of the air inlet shown i the following involves ca 50 % humidity which was the at the tests aimed airhumidity. The attained results is shown to have good correspondence with theoretic estimated values. Recuperative exchanger reached generally oppress result something that now due to this invention can be changed.

The temperature of the water is raised to evaporating temperature (formation of steam and evaporating temperature) through heat supply from the supply air canal of the heat exchanger. To enable water to become gas heat is needed. This (the energy) is called latent evaporisation heat. When the liquid have turned into steam and the temperature of the gas increases more heat is consumed. (See Fig.4.).

The specific latent evaporating heat for water at 760 mm hg is 23×10^{5} joule per kilogram and the latent fusion (melting) heat 33×10^{4} J/kg. The energy needed to evaporate 1 kg water in the heat exchanger will be the equivalent of the energy needed to melt about 8 kg of ice. Of this cooling power the invention is able to benefit ca 90 percent. In Principe other types of heat exchanger may be used with preheating of the air that is meant to be cooled.

A matter of vital importance is that the degree of efficiency at the evaporative heat exchanger is highest possible to enable cooling of supply air below the exhaust air temperature from the room.

It is desirable to go as far below the room temperature as possible and condense water out of the air with the dehumidifier and supply the room with dry air of which low temperature is levelled out with the humidity and temperature of the room. Evaporative cooling might also sink some of the remaining heatload of the room.

One Condition that must be fulfilled to enable evaporation is that the exhaust air is not saturated and the heat exchanger is provided liquid and heat that's needed for the evaporation process.

This heat is supplied to the evaporisation process from the fresh air at its passage trough the heat exchanger. The heat is transferred to the accumulators of the heat exchanger or departing walls from the out door climate.

A result of the extremely high efficiency of the heat exchanger this increase in temperature are changed to exhaust air and bound in the evaporisation process whereby energy collected to alter the phase of the water to gas are able to cool the heat exchanger and the air supply more than what is obtained heat exchange in between supply and exhaust air.

The heat that has been brought is necessary to bring about a effective evaporisation of water in the exhaust. In warm climate with small differences in temperature in between outdoor and indoor sunheat is a profitable source of energy to uphold the described process which have made possible by the extremely high efficiency of the invention.

On the assumption that heat exchangers for ventilated air have high efficiency this Principe with god result and energy saving may be used as well as regenerative, recuperative and combinations of this principles....

At a temperature of ca 20 degrees C exhaust air with 50 percent humidity that saturates with water has the ability to sink the temperature of the air to 14 degree C. At complete dry air that saturates with water the temperature of the air is sunk to ca 6 degree C. Heat is needed to shift phase from water to gas. Heat for evaporisation is collected by a sunheater or adds as heat to the outdoor air that passes through the heat exchanger.

Without evaporative heatexchange, at indoor temperature. 20 degree C a changing down of the out door temperatures occur to the temperature of the air inlet as the following:

<u>Temperature efficiency</u>

	90%	80%	70%	60%	50%
from 30 degree	21	22	23	24	25
40 degree	22	24	26	28	30
50 degree	23	26	29	32	35
60 degree	24	28	32	36	40
70 degree	25	30	35	40	45
80 degree	26	32	38	44	50

At ca 50% humidity that is saturated to ca 100% except consideration to a increased evaporation as result of temperature raise of the air.

<u>Supply air temperature at evaporation in heat exchanger</u>

Temperature sink in ventilation system with temperature efficiency

	30 degree C	40	50	60	70
level of efficiency					
90%	14,6	15,2	15,8	16,4	17
80%	15,2	16,4	17,6	18,8	20
70%	15,8	17,6	19,4	temperature raise	
60%	16,4	18,8	temperature raise		
50%	18	temperature raise			

At theoretic complete dry air that is increased to 100 % humidity except consideration to a increased amount of evaporation as result of temperature increase in the heat exchanger.

106. Supply air temperature at evaporisation in a heat exchanger.

	30 degree C	40	50	60	70
level of efficiency					
90%	7,4	8,8	10,2	11,6	12,8
80%	8,82	11,6	14,4	17,2	20
70%	10,2	14,4	18,6	temperature raise	
60%	11,6	17,2	temperature raise		
50%	13	20	temperature raise		

As result of tests X-WELL regenerative technic with large surfaces in the exchanger easily the best and suitable for this development.

In heat exchanger for evaporative cooling a great part of the cooling is carried out with large quantities of pouring water that isn't evaporated instead it is exchanged (renew) when the water gets warm. Water is a global scarcity. The technic by the invention combined with renewable sources of energy is a profitable alternative to the technic of today that has to be developed in grand scale.

To increase the outdoor temperature by the sun collector the evaporative process is provided with necessary heat to make latent heat by evaporation within reach of cooling.

In warm climate zones with high relative humidity out door it is common to recalculate indoor air and deminish the intake of fresh useful air to an unhygienic level that also result in increased relative humidity indoor and resulting in sick house syndrome.

This invention is a method for air to air heat exchanging and evaporative cooling and means to design these ventilation systems. The invention aim at producing effective heat exchange and evaporative cooling in the heat exchanger itself as supplied air increases upstream in the heat exchanger and heat is supplied from exhaust air down stream the heat exchanger. Hereby the increased ability to dissolve an increased amount of water as gas is taken care of. To use this method to lead away more heat from the supplied fresh air result in a lower temperature of supplied air to the room and that evaporisation of water in the heat exchanger contribute to sink the temperature of the room.

The invention that is suitable on recuperative, regenerative and recuperative/regenerative heat exchangers mean that a well dimensioned amount of sprinkled water in a evaporisation zone in preferable upper part of the heat exchanger. Water that not immediately gazifies in this zone is spread as waterdrips or pouring water. The water follows the down wards aimed airstream to a combined sump and watering devise in the lower part of the exchanger where the water that not has evaporated is collected. Here the airstream change direction whereby the heavy water are separated from the airstream.

Minor water particles and steam follows exhaust air stream and is supplied by additional heat from warm air supply upstream towards outdoor air in the heat exchanger.

Hereby the remaining water and steam on its way out evaporate. A less effective cooling of fresh air is reached when exhaust air is let out from the ventilation system without having been saturated with humidity. Steam in the mouth of exit in exhaust air stream show that the process of evaporisation is ineffective or that the use of water is to high.

The advantage of evaporisation is that unsolved water particles and steam wont join the exhaust air from the ventilation system that minimise the spread of among others, as harmful micro organisms, pollution and bad odour from the ventilation.

In a warm climate zone with high humidity outdoor the cooling of fresh air involve condensation in the heat exchanger. The condense dissolve on the surface of the heat exchanger in supply air channel. The weight of the liquid and low air friction at the departing walls cause the condense to separate from the airstream and pour downwards and be added to the water collecting sump of the evaporation process.

As efficient heat exchange in between warm supply air and dry cool exhaust air together with evaporisation of water in the exhaust will result in a lower temperature than the temperature in the exhaust inlet. This causes a temperature raise in the downstream the supply air channel as the heat exchanger work inversely and heat is supplied to the cool supply air. This heat is partly collected upstream the exhaust and partly from the surrounding where the equipment is placed, when the temperature in the environs is below evaporation temperature in the heat exchanger.

This conditions signify that humidity and steam in the air supply channel evaporate which means diminished disadvantage caused by air borne water particles in supplied air that otherwise brings dangerous micro organisms, pollution, substance that taste and smell.

The starting point where evapòrisation start before or in the heat exchanger and the efficiency of the heat exchanger is a question of vital importance to the amount of energy that gets out of the heat exchanger and cools the supplied fresh air. If the evaporisation process starts to late it my occur that heat flow through the heat exchanger to the already cooled fresh air to such extent that a to high temperature in the supplied air is received. It should be understood that the fresh useful air (supplied air) after the treatment in the equipment has a lower temperature than the exhaust air that leaves the room.

To be able to bring the room as chilly air as possibly it is necessary to prevent that heat pour through the heat exchanger and that the fresh air that is brought indoors is warmed up by remaining heat. In order to sink the temperature of the room it is therefore possible to produce an effective gasification of fine water particles in the fresh air and steam by means of taking heat from the space any one wish to cool,

The invention is during the cold periods of the year a heat exchanger to recover vasted heat from exhaust air. The warm ventilated air preheat the air that is ventilated indoor.

At cyclic, regenerative, heat exchange inlet and outlet ducts are used alternately to transport fresh useful air and exhaust air. In this way momentary condensation of exhaust air in the exchanger and momentary drying up of condensation at fresh air. This result in that the exchanger can be kept free from ice at minus outdoor except extra additional heat. By installing a recuperative heat exchange package with an damper that momentary shift to and from air flows between the canal systems of the heat exchanger similar humidifying - and drying up cycles is obtained. Hereby a smaller admixture of exhaust air in the fresh air.

If you wish complete separated channel systems in air to air heat exchanger very tight constructions is required and that heat for defrosting is added exhaust channel to prevent ice. Commonly this is done by a sin of efficiency of the heat exchanger and supply of a considerable amount of defrosting energy.

The method and means for heatexchange and evaporative cooling in accordance to the invention is for as well regenerative, recuperative and regenerative/recuperative type of ventilation system.

DESCRIPTION

FIG. 1. Show the heatprocess through 1. preheater, 2 the evaporative heat exchanger where heat is changed from exhaust channel and heat reception is carried out through the evaporative process after which airborne humid and heat are leaving the ventilation system and the building. Exhaust air, dark arrow at the bottom to the right Fig. 1. show that temperature loss occur in supply air in the heat exchanger upstream the dehumidifier 3. The air is cooled when it pass the cold surface of the dehumidifier 3. or absorption dehumidifier 3 that diminish the humidity of the supply air before it is provided the room.

FIG. 1, 2, 3 the numbers refer to:

1. preheater
2. evaporative air to air heat exchanger
3. dehumidifier of supplied air
4. out door air
5. indoor air
6. inlet out door air
7. outlet exhaust air
8. inlet treated outdoor air
9. outlet exhaust air

FIG.2. Show: preheater for outdoor air 1, preferably a sunheater that preheat outdoor air upstream evaporative heat exchanger 2, and the dehumidifier 3, then the airstream is led to the orifice the heat exchanger toward outdoor air. Hereby preheated air is to pass trough the whole inside of the equipment and sterilise the whole equipment wit hot air which hinder survival, growth and spread of for the inhabitants and the building dangerous micro-organisms as Bacterius, virus and fungi's. By low airspeed through the ventilation system at sterilising the sterilising temperature is increased. The sterilising process is automatic through that the channel for supplied air to the room and exhaust channel form the room is connected. Evaporative water supply is closed and the airspeed is regulated to enable raise of temperature in the canal system and appliances of the equipment . When desired sterilising time and temperature has been reached the equipment automatically return to normal running.

FIG 3. Show the air streams on its way trough the equipment where the out door air 4, first passes the preheater, sun collector 1, heat treatment part to the dehumidifier, (not shown on FIG 3.) etc. there after passes through the air to air heat exchanger supply air system with evaporative cooling with water and after cooling dehumidifies in order to be let into the room 5, as dry air which temperature and humidity is levelled out with existing room air. The air in the room is added extra humidity by personal load and humid generating activities and leakage. The humidity of the room air ought by ventilation become so dry that it can solve additional humidity from the evaporation and cooling process of the heat exchanger.

FIG.4. Show the evaporisation process and its ability to bind the energy latent.

FIG. 5. Regenerative heat exchange with evaporative cooling.

A = Supply air inlet

B = Supply air outlet

C = Exhaust air outlet

D = Exhaust air inlet

10. Water collecting means for surplus water, sump

11. Exhaust fan (not shown)

12. Damper

13. Damper

14. Accumulator

FIG. 6, 7, 8.

Regenerative heat exchanger with evaporative cooling seen from different sides.

FIG. 9, 10, 11, 12.

Recuperative heat exchanger with cooler and 2 fixed plate heat exchangers.

15. Adjustable bypass to outdoor that afterwards heat and remove aerosols from the supplied air.

FIG. 13. Counter flow heater with common canalisation in between supplied air and exhaust air that at locked dampers at end point have separated canal systems and changed function.

16. Manoeuvred bypass to outdoor air that afterwards heats and remove aerosols.

17. Through opening 17 and closing or supply air channel A and exhaust channel B towards indoor air, first figure, heated outdoor air can first sanitate the supplied air channel system and thereafter the exhaust channel system where after the air is dismissed outdoors.

18, 19. Sprinkler

20. Water collecting means, sump, to surplus water and secluded micro organisms and micro-material.

FIG. 14. Example on distribution of inlet and outlet on equipment seen from above.

FIG. 15. Example on air movement through an evaporative heat exchanger including underlying water collection means, sump, for surplus water and living and dead material.

CLAIMS

Claim 1. This invention relates to an arrangement and method to arrange tempered and dehumidified respective humidified ventilation in buildings, premises, vehicles, caves and similar space with air to air heat exchange, to recover heat, coolness and to generate evaporative cooling characterised in that the heat exchanger consist of one or several parallel or in series arranged heat exchanging parts and that the bottom channel wall consists of a water collection means , sump, and for larger water droplets that have been added upstream (without being evaporated in the air to air heat exchanger) and that the remaining air transported atomised water or steam in the exhaust is supplied with additional heat and evaporate down stream the separation device.

Claim 2. Arrangements and method according to claim 1 characterised in that supply air channel and exhaust channel upstream the water collection means preferably have towards the water collection means flow directed downwards.

Claim 3. Arrangements and method according to claim 1 and 2 characterised in that kinetic energy and/or weight of liquid, living and dead material work for transporting these to the water collection means while gas, small water droplets, aerosols and light particles join the airstreams through the heat exchanger.

Claim 4. Arrangements and method according to previous claim characterised in that the inlet of supplied air and the outlet for supplied air from the heat exchanger adjoin each other or have the same channel wall with adjustable opening that enables bypass of fresh outdoor air to pass by.

Claim 5. Arrangements and method according to any or some previous claims characterised in that cold supply air are heated afterwards by supplied air to prevent outlet of aerosols in the fresh from the ventilation arrangements.

Claim 6. Arrangements and method according to previous claim characterised in that a damper for controlled closing is installed in the mouths between supplied air and exhaust air channels of the aggregate that close supplied air and exhaust air channels towards the room and thereby opens a connection between supplied air and exhaust air in the ventilation arrangements.

Claim 7. According to previous claims characterised in that the water collecting means also serve as supply vessel to a circulating amount of evaporisation liquid.

Claim 8. According to previous claims characterised in that the water collecting means is detachable arranged as a part of the heat exchanger.

Claim 9. According to previous claims characterised in that leakage from the evaporation-heat exchanger by air, water and aerosols preferably is prevented by underpressure in the heat exchanger from a sucking exhaust fan in the outlet (outdoor) and a sucking supply fan in the outlet (into the room)

Claim 10. According to claim 6 characterised in that a damper preferably is regulated automatic in relation to the relative humidity of the air.

Claim 11. According to claim 1 characterised in that evaporisation zone is a limited length of supply air and /or exhaust channel system of the heat exchanger.

Claim 12. According to previous claim characterised in that to the evaporisation zone adjacent part (parts) of the heat exchanger is heat exchanger for air between evaporisation zone and indoor air respective evaporisation zone and outdoor air.

Claim 13. According to claim 11 and 12 characterised in that the cowering of the aggregate transmit heat from indoor air in order to preheat the supplied air to the room.

Claim 14. According to claim 1 characterised in that the cowering have continuos or regulated drainage for surplus liquid from evaporation.

Claim 15. According to claim 1 characterised in that condense from supplied air (fresh useful air) is brought to the water collecting means for evaporating liquid and that remaining airborne in fine particles divided condense or steam downstream (after) the water collecting means in supply air channel additional heat is provided and evaporate downstream the water collecting means.

Claim 16. According to claim 1 or 2 characterised in that atomised water is brought into one or several evaporisation zones before and/or into the heat exchanger of supply air or exhaust air channel.

Claim 17. According to claim 1 or 2 characterised in that heat is supplied from space that is meant to evaporate in order to evaporate airborne water and steam downstream the water collecting means of the equipment aimed for condensed water or water aimed to be evaporated.

Claim 18. According to claim 1 or 2 characterised in that heat is supplied to preheat fresh air (supplied air) downstream water collection means for condense from the heat exchanger down stream the water collection means for evaporisation liquid in exhaust channel or upstream the water collection means for condense in supply air channel.

Claim 19. According to claim 1 characterised in that in the upper part of the heat exchanger a sprinkler system is installed to spray with water and rinse out the channel system of the heat exchanger.

AMENDED CLAIMS

[received by the International Bureau on 20 June 1997 (20.06.97); original claims 1-19 replaced by new claims 1-19 (3 pages)]

Claim 1. A heat exchanging apparatus meant for heat recovery, evaporative cooling, humidifying and/or dehumidifying of ventilated air compromising air to air heat exchanger in between supply air and return air characterised in that the water collecting means, the sumps, for both supply air stream and return air stream are placed at the lower part of the heat exchanger and that both airstreams upstream the sump have a downward direction and that both airstreams downstream the sump have an upward direction.

Claim 2. A heat exchanging apparatus in accordance to claim 1 characterised by that both the supply air stream and the return air stream periodically are selected to change place through the evaporative heat exchanger.

Claim 3. A heat exchanging apparatus in accordance to claim 1 and 2 characterised by that condensed water in any of the airstreams is pureed into the sump, then added to and evaporated in the opposite airstream.

Claim 4: A heat exchanging apparatus in accordance to claim 1 and 2 characterised by that the supply air before the inlet or/and upstream the sump of the evaporative heat exchanger is heated to a temperature that is warmer than the outdoor temperature.

Claim 5: A heat exchanging apparatus in accordance to claim 1 and 2 characterised by that the supply air, down stream the sump, after condensation is provided with additional heat by heat exchange from return air and / or after heated with heat from the outside through the cover of the equipment.

Claim 6: A heat exchanging apparatus in accordance to claim 1 and 2 characterised by that the supply air is heated above the outdoor temperature preferably to a pasteurising and evaporating temperature and that the mouths to the room of supply air channel and of return air channel both are shut while a bypass for supply air opens close to the mouths in between said channels. (FIG. 2 .) 3:5

Claim 7: Arrangements and method according to previous claims regarding a heat exchanging apparatus characterised by that the inlet of supplied air to the heat exchanger and the outlet for supplied air from the heat exchanger adjoin each other or have the same channel wall with an adjustable opening.

Claim 8 : A heat exchanging apparatus according to any or all of previous claims characterised by that the water collecting means also serve as supply vessel to a circulating amount of evaporation liquid in both supply air stream and return air stream.

Claim 9: A heat exchanging apparatus according to any or all previous claims characterised by that the water collecting means is made in one unit serving for both supply and return air channels detachable arranged as a part of the heat exchanger, FIG. 12 . (11), with a departing wall in between for the air and an open connection under the surface for water transport in between the two sumps. (See Fig. 6 and 8 as illustration.)

Claim 10. A heat exchanging apparatus according to claim 1 and 2 characterised in that evaporation zone(s) consist of a limited length of supply air channel and /or exhaust channel of the heat exchanger.

Claim 11. A heat exchanging apparatus according to claim 1 and 2 characterised in that to the evaporation zone adjacent part (parts) of the heat exchanger is heat exchanger for air between evaporation zone and indoor air respective evaporation zone and outdoor air.

Claim 12. A heat exchanging apparatus according to any of previous claims characterised by that the evaporation of water in the return air channel of the heat exchanger at any time is selected to one or several sectors or zones of the elongated heat exchanger.

Claim 13. A heat exchanging apparatus according to claim 11 and 12 characterised in that the cowering of the aggregate transmit heat from indoor air and preheat the supplied air to the room.

Claim 14: A heat exchanging apparatus according to previous claims characterised in that the air transporting fans for supply air and return air generate under pressure in the heat exchanger compared to the air pressure that's surrounds the heat exchanger.

Claim 14. According to claim 1 characterised in that the cowering have continuos or regulated drainage for surplus liquid from evaporation.

Claim 15. A heat exchanging apparatus according to claim 1 and 2 characterised in that condense precipitated from supplied air (fresh useful air) is brought to the water collecting means for evaporating liquid and evaporated in the return air and that it to the remaining precipitated liquid as aerosols in the supply air, e.g. in fine particles divided condense or steam, downstream (after) the water collecting means(sump), in supply air channel is provided with additional heat and evaporate downstream in the supply air channel of the heat exchanger.

Claim 16. A heat exchanging apparatus according to claim 1 or 2 characterised in that atomised water is brought into one or several evaporation zones before and/or into the heat exchanger of supply air or exhaust air channel.

Claim 17. A heat exchanging apparatus according to claim 16 characterised in that atomised water is brought into the evaporation zones periodic and/ or in cycles.

Claim 18. A heat exchanging apparatus according to claim 16 characterised in that atomised water is supplied to one or several evaporation zones before or within the time of the evaporation cycles..

Claim 19. A heat exchanging apparatus according to claim 1 and 2 characterised in that in the upper part of the heat exchanger a sprinkler system is installed to spray with water and rinse out the channel system of the heat exchanger.

Drawings

FIG.1

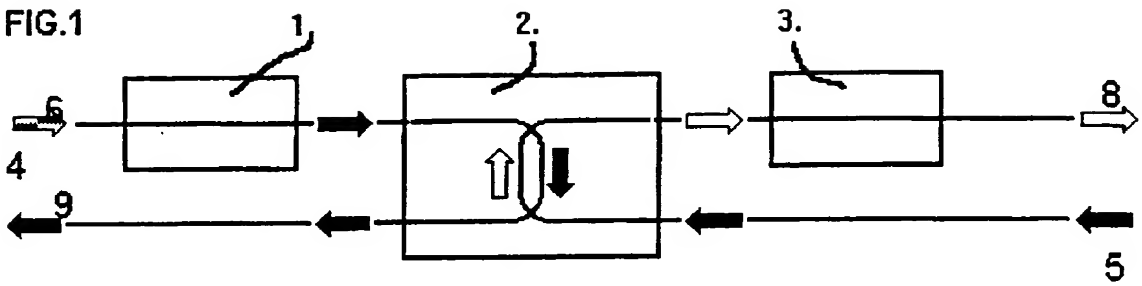


FIG.2

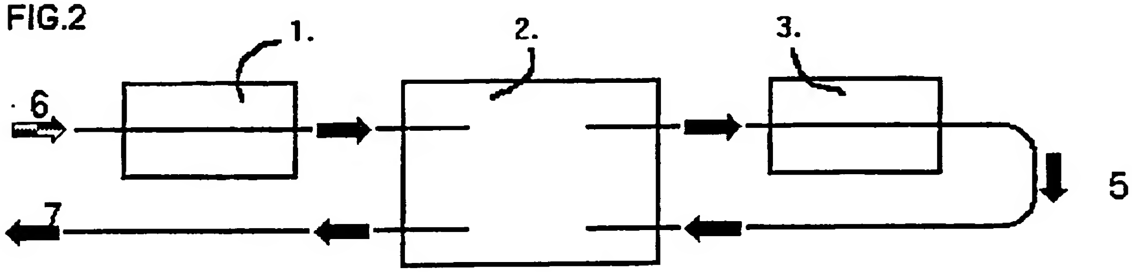


FIG.3

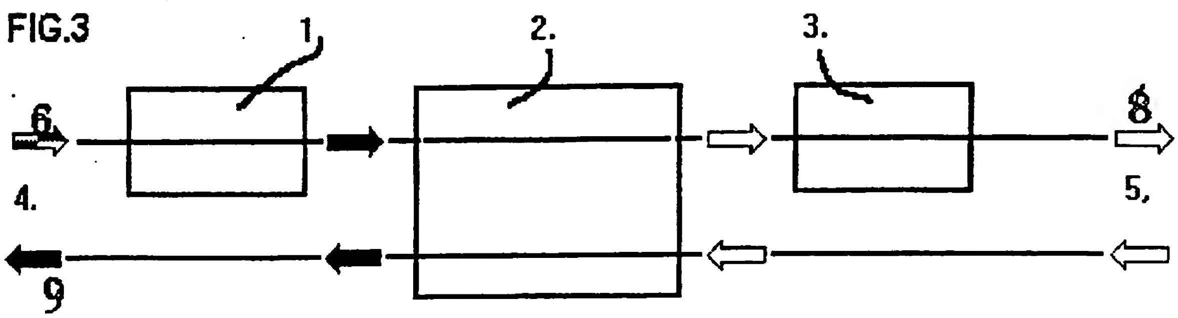


FIG.4

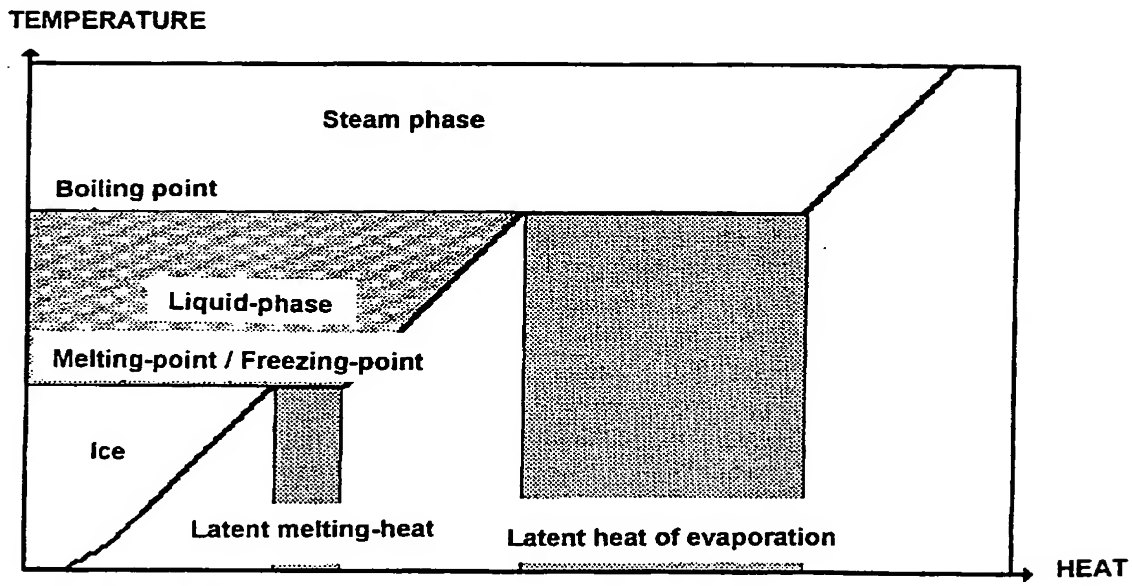


FIG.5

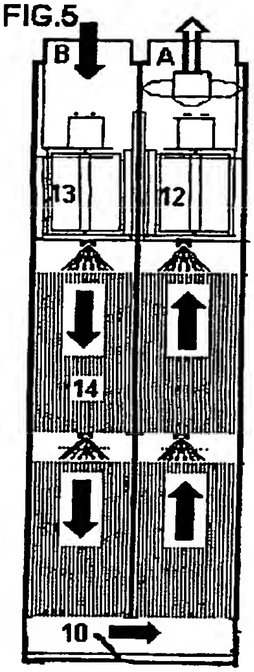


FIG.6

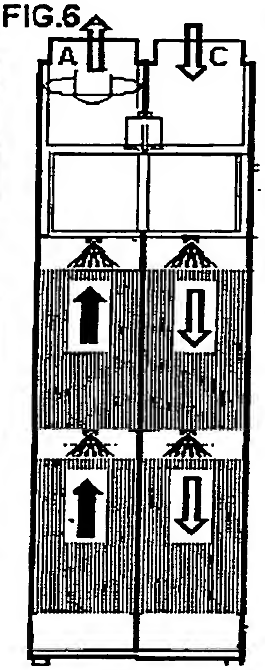


FIG.7

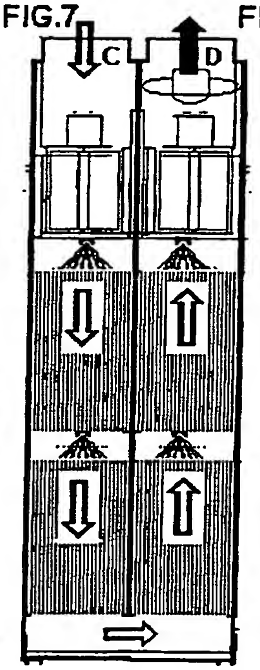


FIG.8

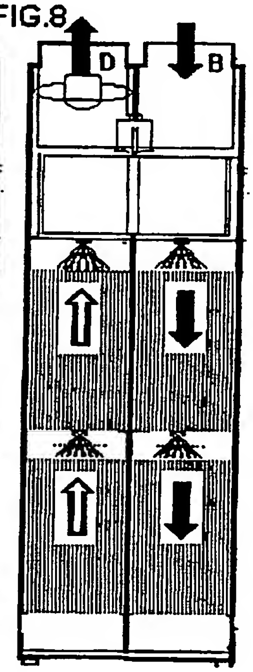


FIG.9

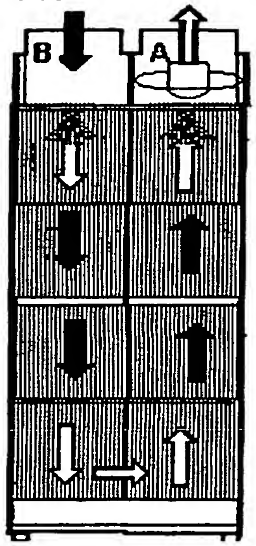


FIG.10

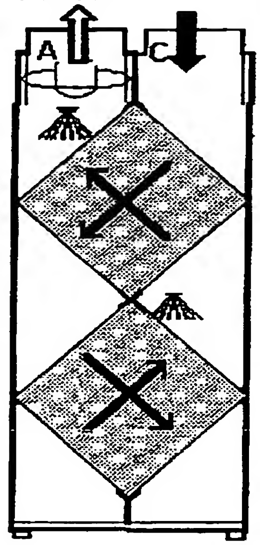


FIG.11

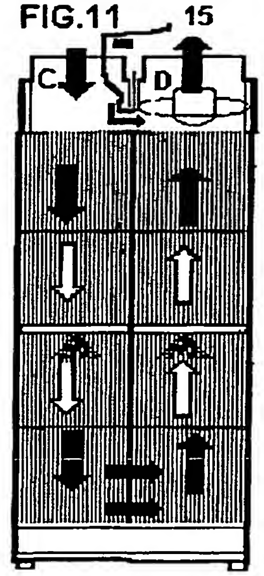


FIG.12

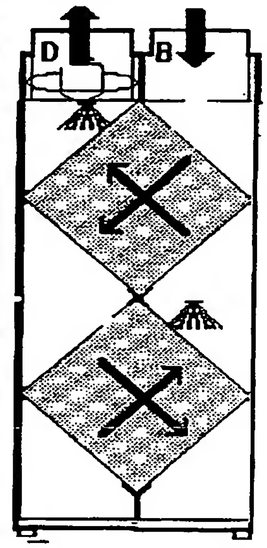


FIG.13

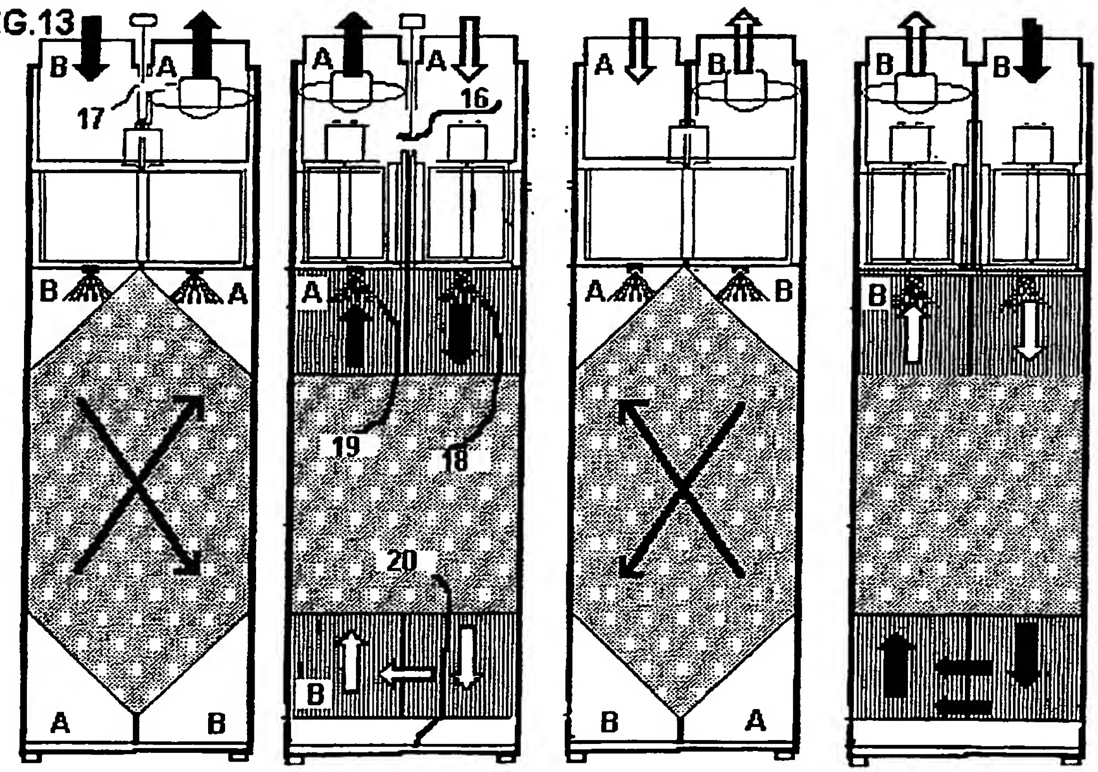


Fig.14

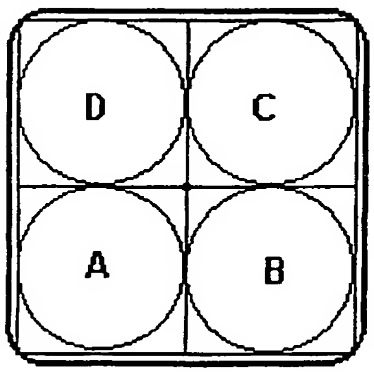
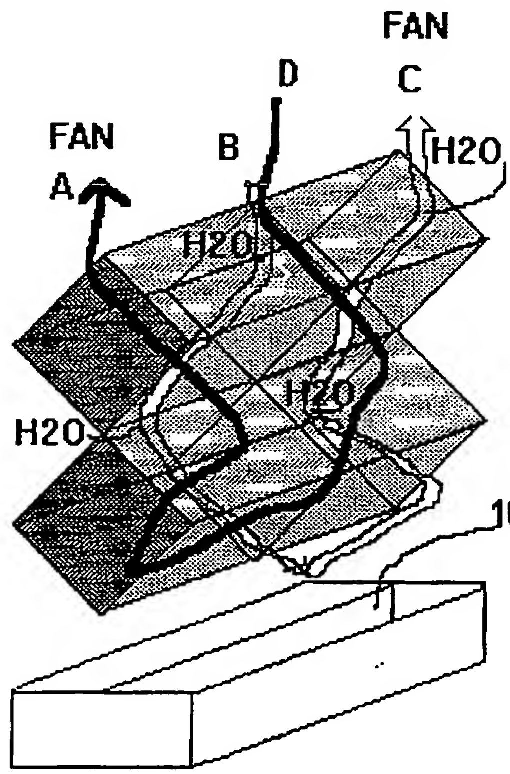


Fig.15



INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 97/00112

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: F24F 3/147, F24F 5/00, F24F 12/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: F24F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2160963 A (VAPOCHILL B V), 2 January 1986 (02.01.86)	1,2,14
Y		4,7,8,15-19
	--	
X	WO 9010828 A1 (PERSSON, SIXTEN), 20 Sept 1990 (20.09.90)	1,2,5,6,19
Y		14-18
	--	
X	DE 4431940 A1 (HUNG GANN CO., LTD.), 7 December 1995 (07.12.95)	1,2
Y		4,7,8,15
	--	

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" ertier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 April 1997	26.04.97
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Helene Eliasson Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 97/00112

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 4344099 A1 (ENGELBRECHT, HANS), 22 June 1995 (22.06.95)	1,2
Y		4,7,8,14-19
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Y	WO 9522726 A2 (X-WELL A/S), 24 August 1995 (24.08.95)	1,2,4,7,8, 14-19
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Y	WO 8701436 A1 (DRICON AIR PTY LIMITED), 12 March 1987 (12.03.87)	1,2,4,7,8, 14,15-19
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 97/00112

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

International application No.
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Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 3,9,11,12,13,18
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
The claims lack clarity and do not fulfil the prescribed PCT-requirements to such an extent that a meaningful international search can be carried on. The claims are not drafted in accordance with Rule 6.4.

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest ☐ The additional search fees were accompanied by the applicant's protest.
☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

02/04/97

International application No.
PCT/SE 97/00112

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